

Abstract/Paper Title

Can We Infer Ocean Dynamics from Altimeter Wavenumber Spectra?

Abstract Text

The wavenumber spectra of sea surface height (SSH) and kinetic energy (KE) have been used to infer the dynamics of the ocean. When quasi-geostrophic dynamics (QG) or surface quasi-geostrophic (SQG) turbulence dominate and an inertial subrange exists, a steep SSH wavenumber spectrum is expected with k^{-5} for QG turbulence and a flatter $k^{-11/3}$ for SQG turbulence. However, inspection of the spectral slopes in the mesoscale band of 70 to 250 km shows that the altimeter wavenumber slopes typically are much flatter than the QG or SQG predictions over most of the ocean. Comparison of the altimeter wavenumber spectra with the spectra estimated from the output of an eddy resolving global ocean circulation model (the Hybrid Coordinate Ocean Model, HYCOM, at $1/25^\circ$ resolution), which is forced by high frequency winds and includes the astronomical forcing of the sun and the moon, suggests that the flatter slopes of the altimeter may arise from three possible sources, the presence of internal waves, the lack of an inertial subrange in the 70 to 250 km band and noise or submesoscales at small scales. When the wavenumber spectra of SSH and KE are estimated near the internal tide generating regions, the resulting spectra are much flatter than the expectations of QG or SQG theory. If the height and velocity variability are separated into low frequency (periods greater than 2 days) and high frequency (periods less than a day), then a different pattern emerges with a relatively flat wavenumber spectrum at high frequency and a steeper wavenumber spectrum at low frequency. The stationary internal tides can be removed from the altimeter spectrum, which steepens the spectral slopes in the energetic internal wave regions. Away from generating regions where the internal waves

are weaker than the QG flow, then the high frequency motions have little impact on the wavenumber spectrum. However, the spectral slope estimates are sensitive to the wavenumber range and altimeter noise. When the mesoscale KE is small, the peak of the enstrophy (mean square vorticity) moves to small scales and the mesoscale band of 70 to 250 km no longer represents the inertial subrange. At small scales the altimeter wavenumber spectra are much flatter than the model spectra which may be the result of noise or submesoscale motions. The model doesn't resolve submesoscale motions which tend to increase the KE at small scales and may explain why the model spectra are much steeper than the altimeter spectra at small scales. However, adding white noise corresponding to the altimeter spectral level at the smallest scales flattens the model spectra similar to the observed altimeter spectra. Thus, it is difficult to infer the ocean dynamics from the altimeter spectral slope over a fixed wavenumber band.

Topic

02 Advances in our understanding of the open ocean

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